A Note on the Response of Coconut (Cocos Nucifera L.) to Size of Weed-Free Circle in Seasonally Arid Coastal Tanzania

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In Tanzanian sandy soils with an average annual precipitation of 1,100 mm and potential evaporation of 2,100 mm, the PB121 hybrid of coconut without any fertilizers applied showed significant increase in growth and early yield response planted in the weed-free circles of radius 2 m during 15-26 months, 2.7-3 m radius at 27-38 months, and 4 m at 39-50 months, as compared with smaller circles.

Levels of N,P, and Mg in coconut leaves are higher in weed-free circles. The growth and yield response as well as the nitrogen content were significantly greater in a complete weeding as compared with large weed-free circles.

INTRODUCTION

Three main ecological areas on mainland Tanzania were investigated for their suitability to coconut cultivation. Since rainfall was limited, the suitability of the areas depended mainly on rooting depth and soil moisture content.

The average annual rainfalls from 1983 to 1986 at Mkuranga and Chambezi were 1,055 and 1,199 mm, respectively (Table 1), as compared with a mean annual potential evaporation at nearby Dar-es-salaam of 2,104 mm (Agrar-und-Hdrotechnik 1980). From June to October, their average was only 32 mm per month and the probability of annual rainfall being less than 790 mm was about 20%.

This paper presented the results of the simple trials on two of these areas (Mkuranga and Chambezi) designed to estimate the effect of weeding on coconut cultivation.

At Mkuranga, the soil on top 50 cm is pale red-brown sandy loam, with red sandy clay loam below, formed from Neogene sandstone. About 200,000 ha of this soil exist. The Chambezi soil is pale-gray, coarse loamy sand formed from coastal sands of the Holocene era. Pale yellow-gray coarse sandy clay loam occurs below 70 cm. There are some 100,000 ha of this soil.

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REVIEW OF LITERATURE

The much better yield of coconut trees nea village houses has been noted (Romney 1984), a though it is not certain as to what extent of it is du to clean weeding nor to the addition of nutrients an water from household sewer. Romney (1982) foun that in coastal Tanzania, East African Tall coconut either with cover crops or with a weeded cassava in tercrop yielded more nuts than those with slashe weeds, while clean-cultivated trees had substantiall better growth and yield than those with grass cove Even at 10 months after planting in these coarse-tex tured soils, some coconut roots measured more tha 2 m from the tree. In other studies like wit sunflower plants, growth has been affected by th leaf low water potential even before photosynthes and respiration occur. Thompson (1976) has show that in sugar cane, the final yield is directly related t the cumulative rate of transpiration during croppin

Manual weeding using a hoe is common in Tan zania and constitutes the most available input fo coconut improvement. Weeding of circles aroun young coconut is cheaper and easier than over-a weeding (Romney 1963).

MATERIALS AND METHODS

The Mkuranga Weed-Free Circle Trial (MK/W began in August 1982 using coconut PB121 hybrid (Malayan Yellow Dwarf × West African Tall) tha had been planted in April 1981. Trees with weed free circles of three sizes were compared with con trol trees surrounded by slashed weeds. Twenty three replicates of single tree plots were made. Th circle sizes are given in Tables 2, 2A, 3, and 3A. Th trees received NPK fertilizer in November 1981 an April 1982, but not thereafter.

The Chambezi Weed-Free Circle Trial (CH/W was similar to trial MK/W, but with 17 replicates Also, circle sizes of CH/W were greater from Augu 1983 to June 1984 (Tables 3 and 3A).

Weeding and slashing were done when neces

sary, but more particularly at the beginning of dry weather in June and January. The traditional method of weeding by hoe is done by scraping the weeds and topsoil away from the plant, including humus and any fertilizer residues, and depositing them outside the weeded circle. In these trials, it is a common practice that the workers remove the weed from the area as they stand outside the circle.

The length of the longest leaf and the width of the distal end of the petiole, as measured from the ground, were noted every 6 months up to June 1983. The number of newly opened leaves were counted also every 6 months up to December 1984 for CH/W, and up to June 1985 for MK/W. The number of open bunches and set and harvested nuts on each tree of both trials were also recorded.

Soil samples from three replicates were analyzed for total moisture content in December 1985, after 4 months of dry weather, to give a first indication of any relationship between moisture conservation and coconut performance. The soils were dried in forced draft at 80°C to constant weight.

The leaf analysis for nitrogen, phosphorous, and magnesium content was done to determine the extent of nutrient absorption of the coconut tree in weed-free circles.

RESULTS AND DISCUSSION

The results showed significant responses in growth and yield from weeding (Tables 2, 2A, 3, and 3A). The responses were significantly highest for the largest weed-free circle size, especially at trial CH/W. Coconut performance at trial MK/W, however, was constrained by P deficiency. Moisture determination in weed-free environment (Table 4) showed no significant differences in relation to distance from the tree and diameter of weed-free circle.

The soil moisture level in weeded condition in relation to depth (Table 5) showed that there were significant differences in moisture content. It was speculated that since sampling was done late during the dry season, it was possible that most of the available soil moisture was taken up. It was noted also that the moisture content almost corresponded to the clay content of the horizons.

Trees in larger weed-free circles had much greater volumes than those in areas covered with weeds. For example, multiplying the number of leaves by leaf length in Tables 2 and 3, the tree volume in the largest weed-free circles in June 1983 was larger by 24% for MK/W trees and 70% for CH/W than those with weeds. Although the trees had no fertilizer applied since April 1982, and some dilution of nutrients in the leaves could have occurred in the larger trees, the results of the analysis of leaf samples taken in October 1985 (Table 6) showed that the levels of N and P were higher when the trees were weed-free. At Mkuranga, coconuts responded to N and P but not to K and Mg (Romney 1987), despite the apparently subcritical leaf level of Mg. The response in growth and yield of those with good weed control was due partly to the removal of weeds as competitors for nutrients.

The effects of widening of the weed-free circle size from 4 m radius (0.72 ha weeded per ha of 143 trees) to the maximum in complete cultivation (a theoretical radius of 4.72 m) have been demonstrated on MK/F/EX and CH/F/EX trials started in November 1981, using PB121 planted in April 1981. As described by Romney (1987), each trial consisted of two replicates of 2^5 factorial layout of N, P, K, Mg, and lime. One replicate has been maintained since planting in weed-free circles of the same size relative to tree age as the largest circles in MK/W and CH/W, respectively. The other replicate has been maintained completely weeded, since December 1984 at CH/F/EX. Responses to weeding and nutrient deficiency (P at MK/F/EX and N, K at CH/F/EX) are shown in Tables 7 and 8. Growth and yield are significantly improved by complete weeding as compared with weeded circles, whether the limiting nutrients are applied or not. Better weeding raises foliar nitrogen in both trials.

CONCLUSION

Removal of weeds competing with coconut trees for nutrient requirements has been expected to enhance coconut performance under Tanzanian conditions, and to help defray cost of establishing coconut productions. Intercropping coconuts with other plants has showed significant positive results (Romney 1986) and the same response was documented in central Ivory Coast (Zarka et al. 1986).

As shown in Tables 2, 2A, 3, and 3A, positive responses were obtained with different sizes of weed-free circles (even without fertilizer application) when growing PB121 hybrids on pale red-brown sandy loam or pale gray coarse loamy sand in seasonally arid coastal Tanzania.

The progressive superiority of larger weeded circles, and in turn complete cultivation, indicates that a lesser density may be better than 143 trees per hectare.

As a result of these trials, weed control in

coconut fields under NCDP control is done by shallow disc (harrowing rather than slashing). Morever, results of trials in Tanzania show that coconuts grow and have better yield with larger weeded circles, and even more so when completely freed of weeds through intercropping with short-season crops. In relation to coconut age, minimum sizes of weed-free circles should be as follows:

Age of Tree	*Weeded Circle Radius*
0 — 12 months	*1.5 m*
12 — 18 months	*2 m*
18 — 24 months	*2.5 m*
2 — 3 years	*3 m*
3 — 4 years	*4 m*
Over — 4 years	*Complete weedin*

TABLE 1. Monthly rainfall distribution at Mkuranga and Chambezi trial sites (Tanzania)

	RAINFALL (mm)							
	MKURANGA				CHAMBEZI			
Month	1983	1984	1985	1986	1983	1984	1985	1986
Jan.	158	130	0	64	0	50	97	9
Feb.	0	0	52	0	63	0	144	4
Mar.	46	52	79	115	58	131	77	133
Apr.	88	333	132	470	242	393	234	358
May	340	215	64	177	407	236	382	157
June	135	99	0	39	34	71	3	23
July	0	39	0	0	6	58	51	13
Aug.	3	4	0	16	14	25	5	28
Sept.	0	0	0	3	6	18	20	22
Oct.	58	44	9	142	142	91	30	32
Nov.	48	196	67	216	0	217	30	380
Dec.	198	60	108	91	34	140	113	117
Total	1074	1172	642	1333	1006	1330	1186	1276
			X = 1055				X = 1199	

TABLE 2. Effects of weed-free circle size on growth and yield parameters at trial MK/W

PARAMETERS	OBSERVATION PERIOD	RADIUS				LSD
		I	II	III	IV	(P = 0.05)
Leaf length*	6/83	100	106	115	116	8
No. leaves*	6/83	100	102	105	107	5
Petiole width*	6/83	100	105	115	120	4
New leaves/tree	7/83 — 6/84	7.6	8.4	8.7	9.4	0.66
New leaves/tree	7/84 — 6/85	10.3	10.7	11.7	11.8	0.8
% Trees bearing	6/85	9	4	17	30	n
% Trees bearing	12/85	9	43	52	70	n
% Trees bearing	6/86	52	48	77	78	n
Open bunches/tree	12/86	3	6	8	10	2.5
Set nuts/tree	12/86	3	5	11	17	9

n not analyzed statistically
* % of control

TABLE 2A. Radii of weed-free circles (m)

OBSERVATION PERIOD	I	II	III	IV
7/82 — 6/83	0	1.0	1.5	2.0
7/83 — 6/84	0	1.4	2.0	2.7
7/84 — 12/86	0	2.0	3.0	4.0

TABLE 3. Effects of weed-free circle size on growth and yield parameters at trial CH/W

PARAMETERS	OBSERVATION PERIOD	RADIUS				LSD
		I	II	III	IV	(P = 0.05)
Leaf length*	12/82	100	105	112	116	n
No. leaves*	12/82	100	109	112	112	n
Petiole width*	12/82	100	107	110	112	n
Leaf length*	6/83	100	112	128	139	7
No. leaves*	6/83	100	110	118	122	14
Petiole width*	6/83	100	107	118	135	9
New leaves/tree	7/83 — 6/84	7.5	8.5	9.1	11.1	0.88
New leaves/tree	7/84 — 12/84	5.3	6.3	6.9	7.1	0.68
% Trees bearing	6/85	24	35	65	71	n
% Trees bearing	6/86	53	88	94	93	n
Open bunches/tree	12/86	6	11	13	16	4.4
Set nuts/tree	12/86	13	17	22	29	14
Harvested nuts/tree	2/86 — 2/87	3	3	8	13	n

n not analyzed statistically
* % of control

TABLE 3A. Radii of weed-free circles (m)

OBSERVATION PERIOD	I	II	III	IV
7/82 — 6/83	0	1.0	1.5	2.0
7/83 — 6/84	0	1.6	2.3	3.0
7/84 — 12/86	0	2.0	3.0	4.0

TABLE 4. Soil moisture (%) vs. distance from the tree (composite samples taken from 0-100 cm depth

DIAMETER OF WEEDED CIRCLE SINCE 7/84 (m)	DISTANCE FROM TREE (m)	SOIL MOISTURE 10/85 (% in dry wt.)
0 (slashed)	1 (weeds)	6.25
	2 (weeds)	6.58
2	1 (bare)	6.58
	3 (weeds)	6.31
3	1 (bare)	6.40
	2 (bare)	6.71
	4 (weeds)	6.86
4	1 (bare)	6.49
	3 (bare)	6.10

TABLE 5. Moisture level at various depths (0-100 cm) for a weed-covered soil

TREATMENT	SOIL 10/85 (% in dry wt.)
Depth (cm) 0 — 25	3.93
25 — 50	5.80
50 — 75	7.89
75 — 100	8.21
$\overline{X}$	6.46
LSD (P = 0.05)	0.34

TABLE 6. Leaf analysis, trial MK/W

DIAMETER OF WEED-FREE CIRCLE SINCE 7/84 (m)	LEAF ANALYSIS 10/85 (% in DM) (Leaf 7 — 10)			
	N	P	K	Mg
0	1.70	0.070	2.05	0.15
2	1.83	0.085	2.00	0.15
3	1.87	0.080	2.00	0.14
4	1.88	0.081	1.88	0.15
Critical levels	2.20	0.130	1.70	0.23

TABLE 7. Effects of weeding and P fertilizer on coconut perfomance and foliar analysis at trial MK/F/EX

CHARACTER	WEED-FREE CIRCLE		COMPLETE WEEDING		STAT. SIGNIF.		
	P_0	P	P_0	P	Weeding	P	Interaction
Leaves/tree (6/84)	23	28	33	39	***	***	ns
Bunches/tree (12/85)	1	12	7	18	***	***	ns
Set nuts/tree (12/85)	0	11	2	27	***	***	**
Nuts/tree 10/85 — 5/86	0	6	1	14	***	***	**
Foliar N(%), 10/84	1.79	1.89	1.87	2.02	***	***	ns
Foliar P(%), 10/84	0.08	0.087	0.08	0.113	***	***	***
Foliar Mg (%), 10/84	0.16	0.17	0.16	0.27	***	***	***

*, **, *** significant at P = 0.05, 0.01, 0.001
ns not significant
n not analyzed statistically

TABLE 8. Effects of weeding and NK fertilizer on coconut performance and foliar analysis at trial CH/F/EX

CHARACTER	WEED-FREE CIRCLES		COMPLETE WEEDING		STAT. SIGNIF.		
	N_0K_0	NK	N_0K_0	NK	Weeding	NK	Interaction
Set nuts/tree (6/86)	37	54	63	68	***	*	**
Harvest (10/85 — 6/86)							
Nuts/tree	7	27	16	40	***	**	ns
Nut wt. (g)	450	570	640	760	***	ns	ns
Foliar N (%), 9/86	1.89	1.98	2.00	2.10	n	n	n
Foliar K (%), 9/86	1.35	1.32	1.21	1.34	n	n	n
Foliar Ca (%), 9/86	0.305	0.310	0.273	0.279	n	n	n

*, **, *** significant at P = 0.05, 0.01, 0.001
ns not significant
n not analyzed statistically

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